

S P E C I F I C A T I O N

RECOMBINANT HUMAN MANNAN-BINDING PROTEINS AND PRODUCING METHOD OF THE SAME

[Technical Field]

The present invention relates to the novel recombinant human Mannan-Binding Proteins (hereinafter simply referred to as "rhMBP") having anti-microorganism activities, in particular, anti-influenza-virus activities and producing method of the same.

[Background Art]

Mannan-Binding Proteins (hereinafter simply referred to as "MBP" and sometimes called as Mannose-Binding Proteins, Mannose-Binding Lectin (MBL) or Mannan-Binding Lectin (MBL)), Conglutinin, Surfactant Protein A (SP-A) and Surfactant Protein D (SP-D), and each of them belongs to a group called as collectin.

With reference to Figure 1, collectin comprises basic constituent unit having the four unique regions of (1) calcium ion (Ca^{2+})-dependent carbohydrate recognition domain (CRD), (2) neck region, (3) collagen-like region and (4) N-terminal region containing cysteine [Malhotra et al., European Journal of Immunology, Vol.22, pp.1437-1445 (1992)], then triple helix are formed by twisting three constituent units (three units) at each of their collagen-like region, and subunits are formed.

Such subunits may further constitute oligomer structure like trimer, tetramer or hexamer. Of the collectins, MBP is specifically binding to Mannose or N-Acetyl-Glucosamine and needs calcium (ion) for such binding, for example, form of MBP from the human serum is homopolymer having, as the constituent units, the subunits in the molecular weight of about 32,000 Da [Teizo Fujita, "Complement Activation and Lectin Pathway", Rinsho-Meneki, Vol.29, No. 3, pp.405-410 (1997)].

In vertebrates, mechanisms involving specific antibody reaction and immune response through the cells are considered as a main host-defense system against invasion of the pathogenic bacteria. However, recently, non-specific immune response by these lectins seems that it may play an important role to neutralize and remove the various microorganisms and virus in the puerile subjects having the maternal transmigration antibody and the undeveloped specific defense system [Super et al., Lancet, Vol.II, pp. 1236-1239 (1989); Nobutaka Wakamiya, Yasuhiko Suzuki, "Anti-Viral activity by Collectin" Rinsho-Meneki, Vol.29, No. 4, pp.508-513 (1997)].

Then, regarding the role of these lectins on biological defense in host organism, it is reported that infection will be easily spread by, for example, the reduction of MBP concentration in blood due to the genetic mutation of MBP gene [Sumiya et al., Lancet, Vol.337, pp.1569-1570 (1991)].

The present inventor once reported that the conglutinin and MBP inhibit infection and hemagglutination inhibition

activities of H1 and H3 Type Influenza A Viruses [Wakamiya et al., Glycoconjugate Journal, Vol.8, p.235 (1991); Wakamiya et al., Biochem. Biophys. Res. Comm., Vol.187, pp. 1270-1278 (1992)].

In particular, with respect to the human MBP (hereinafter simply referred to as "hMBP"), many aspects including their structure and their physiological functions (activities) have recently been investigated eagerly. For example, Ezekowitz et al., reported the analysis results on the hMBP structure as their structure and their gene [Epstein et al., "The collectins in innate immunity", Current Opinion in Immunology, Vol.8, pp.29-35, (1996); Japanese Patent Translation Publication No. 2-504581] .

On the other hand, as an aspect on biological-function of hMBP, hMBP have been considered that it involves with basal immunity like (i) anti-microbial activities, (ii) opsonin activities, (iii) complement activation [Kazuhide Uemura, et al., "Correlation between Structure and Function of Calcium Dependence Animal Lectin on Host Defence", Jikken-Igaku, Vol. 13, No.18 (1995)]. With respect to an clinical application, in view of the findings obtained through analysis on deficit of MBP in blood, it had also been reported that cause of such deficit is gene mutation in collagen-like structure and, thereby, amino acids mutation, and, accordingly, both stabilities of MBP itself and MBP concentration in blood were reduced [Sumiya et al., "Mannose-binding protein, genetic variants and the risk of infection", Q.J Med., No. 89, pp.723-726 (1996); Thomas et al., "Mutation of gene

for mannose-binding protein associated with chronic hepatitis B viral infection", The Lancet, Vol.348, pp.1417-1419 (1996) ; Ezekowitz, "Mannose-binding protein and susceptibility to chronic hepatitis B infection", The Lancet, Vol. 348, pp.1396-1397 (1996)].

Also, it had been reported that MBP concentration in blood is concerned with a pathogenicity of hepatitis B viral and HIV infection. In contrast thereto, it has also been suggested that MBP may involve with lectin pathway through MBP, due to abnormalities on sugar chain of immunoglobulin, in the disorder like chronic rheumatoid arthritis

[Malhotra et al., "Glycosylation changes of IgG associated with rheumatoid arthritis can activate complement via the mannose-binding protein", Nature Medicine, Vol.1, pp.237-243 (1995)] or IgA nephrosis [Mitsuhiro Matsuda et al., "Involvement of Mannan Binding Protein with crisis and progression of IgA nephrosis", Journal of Nephrology Association of Japan, vol.39, No.3, p.235 (1997)] .

Further, according to the recent studies, it had also been reported that, besides the susceptibility to HIV by hMBP, it may involve with latency prior to crisis of AIDS (Acquired Immuno Deficiency Syndrome), hMBP may therefore contribute to prolong the life of AIDS patients [Garred, et al., "Susceptibility to HIV infection and progression of AIDS in relation to variant alleles of mannose-binding lectin", The Lancet, Vol. 349, pp.236-240 (1997)].

Unfortunately, although utilities of hMBP as physiologically active medical materials (components) have

been expected, since the source of which is depended on the animal serum like human or rabbit serum, continuous production thereof was quite difficult and the yield thereof was very small. Further, artificial large scale production system for hMBP by gene recombination techniques have not yet been established.

[Disclosure of Invention]

The present inventions have been established through the continuous research to realize large-scale production of the homogenous hMBP in view of the aforementioned problems in the prior art.

Namely, hMBP (rhMBP) to be obtained by the present invention includes the characteristic rhMBP of:

rhMBP which offers the specific peaks at the molecular weight of 1,000~1,300 kDa, preferably 1,150 kDa, when it is applied to 280nm absorbance in Gel-Filtration Chromatography

rhMBP which offers the specific peaks at the molecular weight of 200~400 kDa, preferably 300 kDa, when it is applied to 280nm absorbance in Gel-Filtration Chromatography ; and

rhMBP which offers the specific peaks at the molecular weight of 1,000~1,300 kDa and 200~400 kDa when it is applied to 280nm absorbance in Gel-Filtration Chromatography.

The present invention may also includes rhMBP prepared according to the method comprising the steps of:

(1) constructing the expression vector pNOW1-hMBP by

inserting into plasmid pNOW1 cDNA corresponding to 66bp~812bp of cDNA from natural Human Mannan-Binding Proteins (hereinafter simply referred to as "native MBP");

(2) preparing transformants by introducing said expression vector pNOW1-hMBP into Chinese Hamster Ovar (CHO) cells which are lack of dihydrofolate reductase (dhfr⁻);

(3) obtaining neomycin resistance cells by culturing said transformants in a culture medium containing neomycin;

(4) obtaining methotrexate (MTX) resistance cells by culturing the selected neomycin resistance cells in a culture medium containing MTX; and

(5) collecting rhMBP from the selected MTX resistance cells.

Amino acids which constitute native hMBP had already been analyzed and been reported by Herman et al [Sastry et al., "The human mannose-binding protein gene. Exon structure reveals its evolutionary relationship to a human pulmonary surfactant gene and localization to chromosome 10", J. Exp. Med. 170(4),1175-1189 (1989)], a base sequence from its cDNA is set out in SEQ.ID.NO:1 and a part of amino acids corresponding to such base sequence is set out in SEQ.ID.NO:28.

Then, the present inventor planned to establish the production system of rhMBP by excising the particular base sequences involving protein expression of rhMBP, namely, cDNA (SEQ.ID.NO:2) corresponding to 66bp~812bp of the base sequences which constitute native hMBP, and incorporating it into an expression system.

[Brief Description of Drawings]

Figure 1 shows a structure of collectins.

Figure 2 shows a preparation scheme of Vector pBBV.

Figure 3 shows a preparation scheme of Plasmid pCV3.

Figure 4 shows a preparation scheme of Plasmid pSVP(D)S-1.

Figure 5 shows a preparation scheme of Plasmid pSVP(D)S-2.

Figure 6 shows a preparation scheme of Plasmid pSVP(D)S/
DHFR.

Figure 7 shows a preparation scheme of Plasmid pSVP(D)S/
NEO.

Figure 8 shows a preparation scheme of Plasmid pCV4.

Figure 9 shows a preparation scheme of Vector pEXP-BL2.

Figure 10 shows a preparation scheme of Plasmid pNOW1.

Figure 11 shows the structure of Plasmid pNOW1.

Figure 12 is a schematic view on the structure of Plasmid
pNOW1-hMBP.

Figure 13 is a graph showing production of rhMBP in the
neomycin (G418) resistance clone.

Figure 14 is a graph showing production of rhMBP in the
MTX resistance clone.

Figure 15 shows results of PAGE analysis on rhMBP.

Figure 16 is a graph showing results of gel-filtrations on
rhMBP.

Figure 17 is a graph showing glyco-binding activities on
rhMBP and native hMBP.

Figure 18 shows activities by rhMBP on Hemagglutination
Inhibition (HI).

Figure 19 is a graph showing activities by rhMBP to

neutralize an infection of Influenza A virus.

Figure 20 is a graph showing activities by rhMBP to bind it to HIV-1, HBV and Influenza A virus.

Figure 21 shows activities by rhMBP to inhibit viral growth (infection spread).

Figure 22 is a graph showing solubility of Sheep Erythrocyte sensitized with rhMBP

[Best Mode for Carrying Out Invention]

rhMBP of the present inventions will be explained in detail along with the following Examples, but, as a matter of course, scope of the present invention should not be limited based on the disclosure of the Examples.

Examples are consisting of: construction of plasmid pNOW1 (Example 1), construction of expression vector pNOW1-hMBP (Example 2), collection of the expression clone from neomycin (G418) resistance cells and MTX resistance cells (Example 3), structural analysis of rhMBP by PAGE analysis and Gel-Filtration Chromatography (Example 4), evaluation of glyco-binding activities on rhMBP and native hMBP (Example 5), evaluation of activities for hemagglutination inhibition (HI) (Example 6), evaluation of neutralization activities (Example 7), evaluation of activities for viral growth (infection spread) inhibition (Example 8), and evaluation of activities on rhMBP for activating complement (Example 9).

Example 1: Preparation of Plasmid pNOW1

(1) Preparation of Back Bone Vector pBBV (Fig.2)

Sense DNA having the base sequence set out in SEQ.ID.NO:3 and Anti-Sense DNA having the base sequence set out in SEQ.ID.NO:4 respectively were synthesized to additionally incorporate them as a linker (BBV linker) for multi-cloning sites into plasmid pUC18 (Takara Shuzo).

Sequence at site to be restricted by restriction enzymes in such linker is 3'-NdeI-SacII-ClaI-EcoRV-SplI-EcoRI-ApaI-5' and 5'-end thereof is Blunt End. Coding region for lacZ were completely removed by digesting 1ng (0.1 μ l) of plasmid pUC18 with restriction enzymes NdeI and PvuII.

Into this solution, 100pmole of sense DNA and anti-sense DNA respectively for BBV linker were added, then 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XLI-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin

respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted therewith DNA of BBV linker were selected and designated them as vector pBBV.

(2) Preparation of Plasmid pCV3 (Fig. 3)

Multi-Cloning sites of plasmid pUC119 were removed. Then, sense DNA having the base sequence set out in SEQ.ID.N0:5 and Anti-Sense DNA having the base sequence set out in SEQ.ID.N0:6 respectively were synthesized to additionally incorporate them as a linker (CV3 linker) for multi-cloning sites into plasmid pUC119 (Takara Shuzo). Sequence at site to be restricted by restriction enzymes in such linker is 5' -HindIII-SacII-PstI-BamHI-ClaI-3' and 3'-end thereof is Blunt End. 1ng (0.1 μ l) of plasmid pUC119 was digested with the restriction enzymes HindIII and EcoRI.

Into the solution containing the plasmids so prepared, 100 pmole of sense DNA and anti-sense DNA respectively for CV3 linker were added, then 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added, and these were reacted at 16°C for 30 minutes.

0.1ml of Escherichia coli competent cell XLI-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution

- was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were
- suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted therinto DNA of CV3 linker were selected and designated them as plasmid pVC3 (for cloning the SV40-related gene).

(3) Preparation of Plasmid pSVP(D)S-1 (Fig. 4)

(3-1) Preparation of Plasmid pSVP1a

5'-sense primer (PS1) having the base sequence set out in SEQ.ID.NO:7 and 3'-anti-sense primer (PS2) having the base sequence set out in SEQ.ID.NO:8 respectively were synthesized to excise SV40 initial promoter having SV40 Ori from plasmid pSV40/BR (obtained from Hiroshima University) containing the whole DNA of SV40 virus ligated with BamHI on pBR322. 5'-end of PS1 primer have restriction site of SacII -EcoRI instead of the PvuII site in the original sequence. Then, 3'-end of PS2 primer have PstI site instead of the original HindIII site. To 1 ng (0.1 μ l) of pSV40/BR genome (from pSV40/BR, obtained from Hiroshima University), 100 pmole of PS1 primer and PS2 primer respectively, 2.5U (0.5 μ l) of Taq polymerase (Takara Shuzo), 20 μ l of PCR Buffer (250mM Tris-HCl (pH 8.3 at 25°C), 375mM KCl, 15mM MgCl₂), 1.0 μ l of 100mM DTT, 0.5 μ l of 10mM dNTP (10mM dATP, dCTP,

dGTP, dTTP) and $0.25\mu\text{l}$ of acetylated BSA(4mg/ml) were added, then were adjusted with the sterilized water to make its final volume $100\mu\text{l}$.

One drop of the mineral oil (Sigma Chemical) was added to these mix solution, then PCR was performed according to the following condition. Namely, after the heat treatment for four minutes at 95°C , three steps treatment consisting of at 95°C for one minute, at 55°C for one minute and at 72°C for two minutes were performed 30 times, and the reaction was terminated by the heat treatment for 10 minutes at 72°C .

Liquid phases were taken from this PCR reaction solution, and, to $10\mu\text{l}$ of which, $2\mu\text{l}$ of $10\times\text{H}$ solution, $20\text{U}(1\mu\text{l})$ of the restriction enzyme SacII as well as $20\text{U}(1\mu\text{l})$ of the restriction enzyme PstI and $7\mu\text{l}$ of the sterilized water were added and it was incubated at 37°C for one hour. The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes.

Approximately 0.35kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised. These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution so produced with a pipet. Plasmid pCV3 were treated with SacII and PstI, then $5\mu\text{l}$ of said DNA solution was added thereto, and $2.0\mu\text{l}$ of solution I attached to DNA ligation kit Ver.2

(Takara Shuzo) were further added thereto, and these were incubated at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the

10054536 1012202
202210 SEEST007

reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42 °C for 60 seconds. It had been left on ice for 2 minutes, 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 µg/ml ampicillin respectively. After the overnight culture at 37 °C, of the plasmids collected from the colonies so produced, plasmids inserted therein DNA of SV40 promoter were selected and designated them as pSV0a. Plasmid pSVPl a containing Psv40DE having SacII-EcoRI site at 5'-end thereof were further prepared by self-ligating such plasmids with the restriction enzyme SphI and removing its enhancer portion.

(3-2) Preparation of Plasmid pSVPlb

Plasmid pSVPlb containing SV40 Promoter Psv40DE for NEO gene cistron were prepared in accordance with the preparation scheme of Example 1 (3-1) except that 5'-sense primer (PS3) having the base sequence set out in SEQ.ID.NO:9 was synthesized instead of 5'-sense primer (PS1). P3 primer have SacII site only at 5'-end thereof (without EcoRI site).

(3-3) Preparation of SV40 polyA

Into 3'-end EcoRI site in SV40 polyA signal sequence of Plasmid pSV40pA-A (from pSV40/BR, obtained from Hiroshima University) having polyadenylation (herein referred to as "polyA") signal derived from SV40 virus genome, SPSV40 linker were ligated, thereby, EcoRI site was altered to Apal-Clal site. Firstly, as SPSV40 linker, sense DNA having the base sequence set out in SEQ.ID.NO:10 and anti-sense DNA having the base sequence set out in SEQ.ID.NO:11 respectively were synthesized.

1ng (0.1 μ l) of Plasmid pSV40pA-A was digested with the restriction enzyme EcoRI. Into the solution so prepared, 100pmole of both sense DNA and anti-sense DNA for SPSV40 linker were added, then 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added thereto, and these were reacted at 16°C for 30 minutes.

0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. After left it on ice for 2 minutes, 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin

respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted thereinto DNA of SV40 polyA were selected and designated them as pSV40pA-B.

(3-4) Preparation of pSVP(D)S-1

To 1ng (0.1 μ l) of Plasmid pSV40pA-B, 20U (1 μ l) of the restriction enzyme BamHI as well as 20U (1 μ l) of the restriction enzyme ClaI and 7 μ l of the sterilized water were added, and it was reacted at 37°C for one hour. The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 0.8kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised. These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution using pipet. Plasmid pSV1a were treated with BamHI and ClaI, then 5 μ l of said DNA solution was added thereto at the ratio of 1ng per 0.1 μ l of the solution, and 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added thereto, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it

with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids additionally inserted therein DNA of SV40 polyA were selected and designated them as Plasmid pSVP(D)S-1.

(4) Preparation of Plasmid pSVP(D)S-2 (Fig. 5)

Plasmid pSVP(D)S-2 containing SV40 Promoter for NEO gene cistron and SV40 polyA were prepared based on Plasmid pSVP1b and DNA of SV40 polyA from pSV40pA-B in accordance with the preparation scheme of Example 1 (3) for Plasmid pSVP(D)S-1.

(5) Preparation of Plasmid pSVP(D)S/DHFR (Fig. 6)

(5-1) Cloning on DHFR gene

mRNA were isolated from 10^7 cells of cultured mouse fibroblast strain 3T3 according to guanidine isothiocyanate method (Meth. Enzymol., 152, p.219, (1987)). Firstly, cells were floated in the flask, then the cells were re-floated in the sterilized PBS and transferred them to the centrifugation tubes. Under the temperature of 0°C or below, the tubes were centrifuged at $450 \times g$ for 10 minutes, and the supernatant was then discarded. To the mix solution consisting of 6M GTG-CsCl, 10mM sodium citrate, 0.1ml β -

mercaptoethanol and 0.5% sarcosil, cells so produced were added, then it was suspended and dissolved therein, and RNA were fragmented by passing it through 18-gauge needle. 2.5 ml of the solution so prepared was overlaid on 2.5ml of the solution containing 5.7M CsCl, and 0.1M EDTA solution in an ultra-centrifugation tube. This was centrifuged at 35,000rpm for 8 hours with an ultra-centrifugation, then the supernatant was discarded carefully, and RNA fractions deposited in the bottom of the tube were extracted with saturated phenol and were dissolved in the sterilized water.

Next, ethanol was added to the deposits and RNA were deposited with centrifugation at 12,000rpm. Then, the deposits were rinsed three times with ethanol and were air-dried. RNA so produced were re-suspended with 3ml of RNase-free water. Concentration of mRNA sample so obtained were about $0.3 \mu\text{g}/\mu\text{l}$ determined by absorbance at 260nm.

(5-2) Preparation of DHFR cDNA

5'-sense primer (PD1) having the base sequence set out in SEQ.ID.NO:12 and 3'-anti-sense primer (PD2) having the base sequence set out in SEQ.ID.NO:13 respectively were synthesized to amplify the gene of DHFR.

5'-end is a sequence artificially combined PstI site with the nonsense pyrimidine sequence of "TCCCTC", while 3'-end is a sequence extended from the termination codon to the BglII site which is about 85b downstream therefrom. $10 \mu\text{l}$ of solution containing $2 \mu\text{g}$ whole RNA was used to synthesize cDNA. Into the sterilized RNase-free tubes, $20 \mu\text{l}$ of PCR

1005453-01220
20210925 16:54:00

Buffer (250mM Tris-HCl (pH 8.3 at 25°C), 375mM KCl, 15mM MgCl₂), 1.0 μl of 100mM DTT, 0.5 μl of 10mM dNTP (10mM dATP, dCTP, dGTP, dTTP), 0.25 μl of acetylated BSA (4mg/ml), 2.0 μg of oligo-dT-primer, 0.5 μl of PCR reverse transcriptase (200 units/μl) and 0.5 μl of RNase-free DEPC water were added. These were incubated at 37°C for 60 minutes, and the reaction was terminated by heating it at 70°C for 15 minutes. cDNA so produced were directly added to the reaction solution for PCR prepared previously. To this solution, 100 pmole of PD1 primer and PD2 primer respectively were added, then, 2.5U (0.5 μl) of Taq polymerase (Takara Shuzo), 20 μl of PCR Buffer (250mM Tris-HCl (pH 8.3 at 25°C), 375mM KCl, 15mM MgCl₂), 1.0 μl of 100mM DTT, 0.5 μl of 10mM dNTP (10mM dATP, dCTP, dGTP, dTTP) and 0.25 μl of acetylated BSA (4mg/ml) were added, and were adjusted with the sterilized water to make its final volume 100 μl. One drop of the mineral oil (Sigma Chemical) was added to these mix solution, then PCR was performed according to the following condition. Namely, after the heat treatment for four minutes at 95°C, three steps treatment consisting of at 95°C for one minute, at 55°C for one minute and at 72°C for two minutes were performed 30 times, and the reaction was terminated by the heat treatment for 10 minutes at 72°C. Liquid phases were taken from this PCR reaction solution, and, to 10 μl of which, 2 μl of 10×H solution, 20U (1 μl) of the restriction enzyme PstI as well as 20U (1 μl) of the restriction enzyme BglII and 7 μl of the sterilized water were added and it was reacted at 37°C for one hour. The reaction solution was

then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 0.65kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised therefrom. These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution using pipet.

(5-3) Preparation of Plasmid pSVP(D)S/DHFR

Plasmid pSVP(D)S-1 was partially digested with the restriction enzymes PstI and BamHI (this treatment is due to the presence of one Psti site in SV40 polyA). 0.5 μ l of DHFR DNA solution was added to 0.1 μ l (1 ng DNA) of this solution, 5'-end thereof is bond with PstI, while 3'-end thereof is bond with the projected ends of BamHI and BglII. At this moment, 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were added thereto, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded.

Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were

inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids additionally inserted therein DNA of DHFR as well as the restriction site for *Apa*I were selected and designated them as Plasmid pSVP(D)S/DHFR.

(6) Preparation of Plasmid pSVP(D)S/NEO (Fig. 7)

For Neomycin Phosphotransferase Gene (NEO gene) region, a sequence conjugated NEO gene translation region with the transposon sequence of 354 bases at 5'-upstream was used. This sequence is from Tn5 and is contained in pSV2-neo (J. Mol. Appl. Genet., p.1327 (1982)), therefore, this was prepared by excising it from pSV2-neo. Firstly, 5'-sense primer (PN1) having the base sequence set out in SEQ.ID.NO: 14 and 3'-anti-sense primer (PN2) having the base sequence set out in SEQ.ID.NO:15 respectively were synthesized. 5'-end of PN1 primer have PstI site instead of HindIII site in the original sequence. Then, 3'-end of PN2 primer have BamHI site instead of SmaI site in the original sequence.

To 1 ng (0.1 μ l) of pSV2-neo genome, 100pmole of PN1 primer and PN2 primer respectively were added, then, 2.5U (0.5 μ l) of Taq polymerase (Takara Shuzo), 20 μ l of PCR Buffer (250mM Tris-HCl (pH 8.3 at 25°C), 375mM KCl, 15mM MgCl₂), 1.0 μ l of 100mM DTT, 0.5 μ l of 10mM dNTP (10mM dATP, dCTP, dGTP, dTTP) and 0.25 μ l of acetylated BSA (4mg/ml) were added, and were adjusted with the sterilized water to

make its final volume 100 μ l. One drop of the mineral oil (Sigma Chemical) was added to these mix solution, then PCR was performed according to the following condition. Namely, after the heat treatment for four minutes at 95 $^{\circ}$ C, three steps treatment consisting of at 95 $^{\circ}$ C for one minute, at 55 $^{\circ}$ C for one minute and at 72 $^{\circ}$ C for two minutes were performed 30 times, and the reaction was terminated by the heat treatment for 10 minutes at 72 $^{\circ}$ C. Liquid phases were taken from this PCR reaction solution, and, to 10 μ l of which, 2 μ l of 10 \times H solution, 20U (1 μ l) of the restriction enzyme PstII as well as 20U (1 μ l) of the restriction enzyme BamHI and 7 μ l of the sterilized water were added and it was reacted at 37 $^{\circ}$ C for one hour. The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 1.3kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised therefrom.

These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution so produced with a pipet.

Plasmid pSVP(D)S-2 was partially digested with the restriction enzymes PstI and BamHI (this treatment is due to the presence of one PstI site in SV40 polyA). 0.5 μ l of DNA solution of NEO gene were added to 0.1 μ l (1ng DNA) of this solution, thereby, PstI site and BamHI site were ligated.

With respect to this reaction, 2.0 μ l of solution I

attached to DNA ligation kit Ver.2 (Takara Shuzo) were added thereto, and these were reacted at 16°C for 30 minutes. 0.1 ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds.

It had been left on ice for 2 minutes, 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted therein to DNA of transposon sequence containing NEO gene were selected with regard to G418 resistance.

Further, anti-sense primer for introducing mutation which have the base sequence set out in SEQ.ID.NO:16 was synthesized to alter the base of "A" to "C" wherein the base "A" is immediately next to the initiation codon "ATG" in NEO gene translation region. 100pmole of this anti-sense primer was added to 1 ng (1 μ l) of pSVP(D)S/NEO genome, and was site-directed mutated by PCR in vitro Mutagenesis Kit (Takara Shuzo).

2.5U (0.5 μ l) of Taq polymerase (Takara Shuzo), 20 μ l of PCR Buffer (250mM Tris-HCl (pH 8.3 at 25°C), 375mM KCl, 15mM

MgCl₂), 1.0 μ l of 100mM DTT, 0.5 μ l of 10mM dNTP (10mM dATP, dCTP, dGTP, dTTP) and 0.25 μ l of acetylated BSA (4mg/ml) were added, and were adjusted with the sterilized water to make its final volume 100 μ l. One drop of the mineral oil (Sigma Chemical) was added to these mix solution, then PCR was performed according to the following condition.

Namely, after the heat treatment for four minutes at 95°C, three steps treatment consisting of at 95°C for one minute, at 55°C for one minute and at 72°C for two minutes were performed 30 times, and the reaction was terminated by the heat treatment for 10 minutes at 72°C. Plasmid vector so produced was designated as Plasmid pSVP(D)S/NEO.

(7) Preparation of Plasmid pEXP-BL2

(7-1) Preparation of Plasmid pCV4 (Fig. 8)

Sense DNA having the base sequence set out in SEQ.ID.NO:17 and anti-sense DNA having the base sequence set out in SEQ.ID.NO:18 respectively were synthesized as a linker (CV4 linker) for Multi-Cloning Site to remove the Multi-Cloning site of Plasmid pUC18 (Takara Shuzo) and additionally incorporate therein Multi-Cloning Site (MCS) related gene.

Sequences at a site to be restricted by the restriction enzymes in this linker is 3'-HindIII-EcoRV-ClaI-NotI-KpnI-XbaI-BalII-SplI-EcoRI-5'. 1 ng (0.1 μ l) of Plasmid pUC18 was treated with the restriction enzymes of HindIII and EcoRI.

Into the solution containing the plasmids so produced, 100 pmole of sense DNA and anti-sense DNA respectively for CV4

linker were added, then 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds.

It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight cultured at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted therein DNA of CV4 linker were selected and designated them as vector pCV4.

(7-2) Preparation of P_{CMV} (Fig. 9)

5'-sense primer (PC1) having the base sequence set out in SEQ.ID.NO:19 and 3'-anti-sense primer (PC2) having the base sequence set out in SEQ.ID.NO:20 respectively were synthesized to excise P_{CMV} from plasmid pSV2-neo/EcoH (obtained from Tokai University) prepared by incorporating the approximately 6 kb sequence containing the promoter/enhancer region of hCMV MIE antigen into pSV-Neo. 5'-end of

PC1 primer have restriction site of EcoRV, while 3'-end of PC2 primer have ClaI site. To 1ng (0.1 μ l) of the plasmid pSV2-neo/EcoH genome, 100pmole of PC1 primer and PC2 primer respectively, 2.5U (0.5 μ l) of Taq polymerase (Takara Shuzo), 20 μ l of PCR Buffer (250mM Tris-HCl (pH 8.3 at 25°C), 375mM KCl, 15mM MgCl₂), 1.0 μ l of 100mM DTT, 0.5 μ l of 10mM dNTP (10mM dATP, dCTP, dGTP, dTTP) and 0.25 μ l of acetylated BSA (4mg/ml) were added, then were adjusted with the sterilized water to make its final volume 100 μ l. One drop of the mineral oil (Sigma Chemical) was added to these mix solution, then PCR was performed according to the following condition. Namely, after the heat treatment for four minutes at 95°C, three steps treatment consisting of at 95°C for one minute, at 55°C for one minute and at 72°C for two minutes were performed 30 times, and the reaction was terminated by the heat treatment for 10 minutes at 72°C. Liquid phases were taken from this PCR reaction solution, and, to 10 μ l of which, 2 μ l of 10×H solution, 20U (1 μ l) of the restriction enzyme EcoRV as well as 20U (1 μ l) of the restriction enzyme ClaI and 7 μ l of the sterilized water were added and it was reacted at 37°C for one hour.

The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 0.6kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised. These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating

the solution so produced with a pipet.

(7-3) Insertion of P_{CMV} into Plasmids

1 ng (0.1 μ l) of Plasmid pCV4 were treated with the restriction enzymes of EcoRV and ClaI, then 0.5 μ l of P_{CMV} DNA solution was added, and it was ligated to between EcoRV site and ClaI site. Into this reaction, 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added thereto, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded.

Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted therein P_{CMV} DNA were selected and designated them as pCV4/CMV.

(7-4) Isolation of DNA having bGH polyA

While cell tissues obtained from bovine liver were sliced on the dry ice, they were extracted with the buffer (150mM NaCl, 10mM Tris-HCl (pH 8.0), 10mM EDTA, 0.1% SDS) containing Proteinase K solution adjusted its concentration to be 100 μ g/ml and were mixed gently. After one hour incubation at 55°C, they were further incubated overnight at 37°C. Then, equivalent amount of the neutral phenol equilibrated with Tris were added thereto and they were mixed gently at the room temperature for 20 minutes.

After the centrifugation at 2,000 \times g under the room temperature for 10 minutes, the upper layer (5ml) so separated was collected, then the collected layers were transferred to the fresh tubes, and they were centrifuged again under the same condition. Upper layer was collected again and was transferred to the fresh tubes, and they were re-centrifuged under the same condition. Upper layer thereof was collected again and was transferred to the fresh tubes, then, two times volume of 100% ethanol were overlaid thereon, and the buffer and ethanol were mixed with gentle agitation. DNA so produced were collected by rolling it with glass-stick then were air-dried, and 5ml of TE solution was added thereto and it was dissolved at 4°C overnight.

Concentration of DNA sample so obtained were about 0.5 μ g/ μ l determined by absorbance at 260nm.

(7-5) Insertion of bGH polyA into Plasmids

Two types of bGH polyA sequences, each of which have the different sites on the restriction enzymes, were prepared to doubly conjugate bGH polyA sequences. Firstly, two pairs of 5'-sense primer and 3'-anti-sense primer, namely, one pair of 5'-sense primer (PB11) having the base sequence set out in SEQ.ID.NO:21 and 3'-anti-sense primer (PB12) having the base sequence set out in SEQ.ID.NO:22, and the other pair of 5'-sense primer (PB21) having the base sequence set out in SEQ.ID.NO:23 and 3'-anti-sense primer (PB22) having the base sequence set out in SEQ.ID.NO:24 were synthesized.

bGH polyA sequences having at its both ends the desired sequences to be restricted by restriction enzymes were prepared from 100ng of DNA sample so synthesized by using PCR template.

Firstly, to 100ng ($1\mu\text{l}$) of DNA sample, 100pmole of sense primer PB11 and anti-sense primer PB12 respectively, 2.5U ($0.5\mu\text{l}$) of Taq polymerase (Takara Shuzo), $20\mu\text{l}$ of PCR Buffer (250mM Tris-HCl (pH 8.3 at 25°C), 375mM KCl, 15mM MgCl_2), $1.0\mu\text{l}$ of 100mM DTT, $0.5\mu\text{l}$ of 10mM dNTP (10mM dATP, dCTP, dGTP, dTTP) and $0.25\mu\text{l}$ of acetylated BSA (4mg/ml) were added, then were adjusted with the sterilized water to make its final volume $100\mu\text{l}$. One drop of the mineral oil (Sigma Chemical) was added to these mix solution, then PCR was performed according to the following condition.

Namely, after the heat treatment for four minutes at 95°C , three steps treatment consisting of at 95°C for one minute, at 55°C for one minute and at 72°C for two minutes were

performed 30 times, and the reaction was terminated by the heat treatment for 10 minutes at 72°C. Liquid phases were taken from this PCR reaction solution, and, to 10 μ l of which, 2 μ l of 10 \times H solution, 20U (1 μ l) of the restriction enzyme XbaI as well as 20U (1 μ l) of the restriction enzyme BglII and 7 μ l of the sterilized water were added and it was reacted at 37°C for one hour.

The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 0.23kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised. These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution so produced with a pipet.

Into 0.1 μ l (1ngDNA) of solution wherein Plasmid pCV4/CMV was treated with XbaI and BglII, 0.5 μ l of DNA solution noted above were added, then 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added, and these were reacted at 16°C for 30 minutes.

0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour.

The solution was centrifuged at 5,000rpm for one minute,

the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37 $^{\circ}$ C, of the plasmids collected from the colonies so produced, plasmids inserted therein into bGH polyA DNA were selected and designated them as pCV4/CMV-bGH1.

(7-6) Preparation of Vector pEXP-BL2

To 1ng of DNA sample prepared through PCR amplification from Primers PB11 and PB12, 100pmole of sense primer PB21 and anti-sense primer PB22 respectively, 2.5U (0.5 μ l) of Taq polymerase (Takara Shuzo), 20 μ l of PCR Buffer (250mM Tris-HCl (pH 8.3 at 25 $^{\circ}$ C), 375mM KCl, 15mM MgCl₂), 1.0 μ l of 100mM DTT, 0.5 μ l of 10mM dNTP (10mM dATP, dCTP, dGTP, dTTP) and 0.25 μ l of acetylated BSA (4mg/ml) were added, then were adjusted with the sterilized water to make its final volume 100 μ l. One drop of the mineral oil (Sigma Chemical) was added to these mix solution, then PCR was performed according to the following condition. Namely, after the heat treatment for four minutes at 95 $^{\circ}$ C, three steps treatment consisting of at 95 $^{\circ}$ C for one minute, at 55 $^{\circ}$ C for one minute and at 72 $^{\circ}$ C for two minutes were performed 30 times, and the reaction was terminated by the heat treatment for 10 minutes at 72 $^{\circ}$ C. Liquid phases were taken from this PCR reaction solution, and, to 10 μ l of which, 2 μ l of 10 \times H solution, 20U (1 μ l) of the restriction enzyme BamHI as well as 20U

(1 μ l) of the restriction enzyme SplI and 7 μ l of the sterilized water were added and it was reacted at 37°C for one hour. The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 0.47kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised.

These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution so produced with a pipet.

Into 0.1 μ l (1 ngDNA) of solution wherein Plasmid pCV4/CMV -bGH1 was treated with BglII and SplI, 0.5 μ l of DNA solution noted above were added, then 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XLI-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded.

Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates

containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted thereinto the second bGH polyA DNA, namely, plasmids ((bGH polyA)²) inserted thereinto and doubly bond to bGH polyA DNA were selected and designated them as cassette vector pEXP-BL2 having MCS cistron.

(8) Preparation of Plasmid pNOW1 (Fig.10)

(8-1) Preparation of Plasmid pNOW-a

To 100ng (1 μ l) of Plasmid pSVP(D)S/DHFR, 1 μ l of 10 \times H solution was added, then, 20U (1 μ l) of the restriction enzyme EcoRI and 20U (1 μ l) of the restriction enzyme Apal were further added, and these were reacted at 37°C for one hour. The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 1.75kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised. These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution so produced with a pipet. This DNA sequence constituted DHFR gene cistron and was consisted of P_{SV40}DE, Mu-DHFR (mutated) gene and SV40 polyA.

On the other hand, 1ng (1 μ l) of Plasmid pBBV 10 be inserted thereinto DNA sequence which constitutes DHFR gene cistron were treated with the restriction enzyme EcoRI and Apal. 0.5 μ l of solution containing DNA sequence which

constitutes DHFR gene cistron were added to the solution containing the plasmids so prepared, thereby, it was ligated between EcoRI and ApaI site. Into this reaction, 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added thereto, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds.

It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively.

After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids additionally inserted therein DNA which constitutes DHFR gene cistron were selected and designated them as pNOW-a.

(8-2) Preparation of Plasmid pNOW-bp

To 100ng (1 μ l) of Plasmid pSVP(D)S/NEO, 1 μ l of 10 \times H solution was added, then, 20U (1 μ l) of the restriction enzyme SacII and 20U (1 μ l) of the restriction enzyme ClaI

were further added, and these were reacted for one hour.

The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes.

Approximately 2.4kb band was detected by exposing it to the ultraviolet rays of 360nm wavelength and was excised.

These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution so produced with a pipet. This DNA sequence constituted NEO gene cistron and was consisted of Psv40DE, transposon sequence, Mu-NEO (mutated) gene and SV40 polyA.

On the other hand, 1ng (1 μ l) of Plasmid pNOW-a to be inserted therinto DNA sequence which constitutes NEO gene cistron were treated with the restriction enzyme SacII and ClaI. 0.5 μ l of solution containing DNA sequence which constitutes NEO gene cistron were added to the solution containing the plasmids so prepared, thereby, it was ligated between SacII and ClaI site. Into this reaction, 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added thereto, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XLI-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds.

It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thercto and was cultured by shaking it with a shaker at 37°C for one hour. The solution

was centrifuged at 5,000rpm for one minute. the supernatant was then discarded.

Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids additionally inserted thereinto DNA which constitutes NEO gene cistron were selected and designated them as pNOW-bp.

(8-3) Preparation of Plasmid pNOW-b

ClaI site was removed by substituting the newly synthesized ApaI-EcoRV linker for a serial sites of ApaI-ClaI-EcoRV to remove the ClaI site of multi-cloning site in Plasmid pNOW-bp so prepared. Firstly, as this linker, sense DNA having the base sequence of 5'-CGAT-3' and anti-sense DNA having the base sequence of 3'-CGGGCTA-5' were respectively synthesized. 1ng (0.1 μ l) of Plasmid pNOW-bp were digested with the restriction enzymes of ApaI and EcoRV. To the solution containing the plasmids so prepared, 100 pmole of ApaI-EcoRV linker sense DNA and anti-sense DNA respectively were added, then, 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by

heat-shock at 42°C for 60 seconds. It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids additionally inserted thereinto DNA which constitutes NEO gene cistron were selected and designated them as pNOW-b.

(8-4) Preparation of Plasmid pNOW1

To 100ng (1 μ l) of Plasmid pEXP-BL2, 1 μ l of 10 \times H solution was added, then, 20U (1 μ l) of the restriction enzyme EcoRV and 20U (1 μ l) of the restriction enzyme SplI were further added, and these were reacted for one hour. The reaction solution was then applied to an electrophoresis employing 0.8% agarose-gel at 50mA for 30 minutes. Approximately 1.1kb band was detected by exposuring it to the ultraviolet rays of 360nm wavelength and was excised. These agarose fragments were poured into 1.5ml tubes, then the tubes were centrifuged at 15,000rpm for 10 minutes, and DNA solution was obtained by separating the solution so produced with a pipet. This DNA sequence constituted MCS cistron and was consisted of Pcmv, MCS-B and (bGH polyA)².

On the other hand, 1 ng (1 μ l) of Plasmid pNOW-b to be inserted therein DNA sequence which constitutes MCS cistron were treated with the restriction enzyme EcoRV and SplI. 0.5 μ l of solution on DNA sequence which constitutes MCS cistron were added to the solution containing the plasmids so prepared, thereby, it was ligated between EcoRV and SplI site. Into this reaction, 2.0 μ l of solution I attached to DNA ligation kit Ver.2 (Takara Shuzo) were further added thereto, and these were reacted at 16°C for 30 minutes. 0.1ml of Escherichia coli competent cell XL1-BLUE (STRATAGENE) was added to the reaction-solution, then the solution was left on ice for 30 minutes to proceed the reaction followed by heat-shock at 42°C for 60 seconds.

It had been left on ice for 2 minutes, then 0.9ml of SOC medium (Toyobo) was added thereto and was cultured by shaking it with a shaker at 37°C for one hour. The solution was centrifuged at 5,000rpm for one minute, the supernatant was then discarded. Deposited competent cells were suspended with the solution remained in the centrifugation tube, then these were inoculated at the ratio of 1:10 into two ampicillin plates containing 100 μ g/ml ampicillin respectively. After the overnight culture at 37°C, of the plasmids collected from the colonies so produced, plasmids inserted therein DNA which constitutes MCS cistron were selected and designated them as pNOW1.

Structure of Plasmid pNOW1 is shown in Figure 11. Then, whole base sequences of Plasmid pNOW1 is set out in SEQ.ID. NO:25.

Example 2 : Construction of Expression Vector pNOW1-hMBP

First of all, hMBP sequences from its initiation codon to its stop codon were amplified from human liver cDNA library (Clontech) with a zymoreacter (Alto) by using the primer having the base sequence of AAGGAAAAAAGCGGCCGCATGTCCCTGTTTCC ATCACTC (SEQ. ID. NO:26) and that having the base sequence of GCTCTAGATCAGATAGGGAACACAGAC (SEQ. ID. NO:27).

hMBP cDNA so obtained were digested with the restriction enzymes of NotI and XbaI, and cDNA corresponding to 66~812 bp in such cDNA (SEQ. ID. NO:2) so obtained were employed as an insert.

Then, the expression vector pNOW1 prepared in Example 1 was digested with the restriction enzymes of NotI and XbaI, and said insert was inserted with DNA ligation kit (Takara Shuzo) into the downstream of cytomegalovirus promoter (pCMV), namely, between pCMV and BGP polyA (corresponding to (bGHpA)² in Figure 11). The expression vector so prepared was designated as Plasmid pNOW1-hMBP, and its structure is illustrated as schematic view in Fig.12.

Example 3 : Selection of Expression Clone

- (1) Introduction of Expression Vector pNOW1-hMBP
into Chinese Hamster Ovar (CHO) cells
lacking Dihydrofolate Reductase (dhfr⁻)

Iscove's Modified Dulbecco's Medium (IMDM; GIBCO) not contained thercin hypoxanthine and thymidine but supplemented thereto 10% bovine fetal serum (FCS, GIBCO) was prepared, then DG44 CHO cell strain lacking DHFR gene

continued for two weeks under the condition at 37°C and 5 % CO₂. 84 wells of 960 wells have active cells, and there were G418 resistance cells (clones).

When the productivities of hMBP by such G418 resistance clones were studied, most of G418 resistance clones exhibit high productivity on hMBP.

Some clones were selected from the clones having the demonstrated hMBP productivities and were inoculated into 25cm² culture flask. Cultivation were continued until density of the cells were increased, and the cell number measured at that moment was 3×10^6 cells/25cm² culture flask. Culture supernatant from each of culture flasks were discarded, then 2ml of IMDM supplemented thereto 10% FCS were added thereto wherein components of such IMDM were identical to IMDM previously noted, and culture were performed for four days, thereafter, culture supernatant so obtained were collected. When amount of hMBP (rhMBP) in the collected culture supernatant were measured, there were production of over 5 µg/ml in some culture flasks. Amounts of hMBP were quantified with regard to the native MBP as a control, anti-rabbit polyclonal antibody (expressed in Escherichia coli) for carbohydrate recognition domain (CRD) and neck region in the collectin and hMBP (subjects to be quantified), along with the method of Suzuki et al., (Y. Suzuki, et al., "Characterization of Recombinant Bovine Conglutinin Expressed in a Mammalian Cell", Biochem. Biophys. Res. Commun., 238, pp.856-863 (1997)). Results on four clones having high productivities are shown in the graph of

Figure 13. hMBP production by the clone having the highest productivity was $23.3 \mu\text{g/ml}$.

(3) Production of MTX Resistance CHO Cells

After stabilizing the hMBP production clones by further subculturing them, gene amplification was performed with a medium supplemented thereto the low concentration MTX.

Firstly, each of the selected two cell clones were mixed with IMDM supplemented thereto 10% dialyzed FCS (JRH Bioscience) and contained 5nM MTX and $400 \mu\text{g/ml}$ of Neomycin (G418), thereafter, amount of 0.1 ml/well of which were inoculated (poured) into 10 pieces of 96-well microplate. When the culture had been continued for two weeks under the condition at 37°C and 5% CO_2 , most of 960 wells have active cells, and there were 5nM MTX resistance cells (clones). When the productivities of hMBP by such 5nM MTX resistance clones were studied, most of 5nM MTX resistance clones exhibit high productability on hMBP. Five clones were optionally selected from such clones, then each of which were inoculated into 25cm^2 culture flasks, and the culture were continued until density of the cells were increased.

Culture supernatants were discarded, then 2 ml of IMDM (supplemented thereto 5nM MTX and $400 \mu\text{g/ml}$ of G418) were added thereto, and culture were performed for four days, thereafter, culture supernatant so obtained were collected and production level of hMBP were measured. Amounts of hMBP were quantified according to the similar method noted in

Example 3(1). Results are shown in the graph of Figure 14. hMBP production by the clone having the highest productivity was $54.1 \mu\text{g/ml}$.

Example 4 : Analysis of Structure of rhMBP by PAGE Analysis
and Gel-Filtration Chromatography

(1) Purification of rhMBP

The clone having the highest productivity in the clones so produced was inoculated into 225cm^2 culture flask and was the culture were continued until density of the cells were increased. Then, the culture supernatants were discarded, then 50ml of CHO-S-SFM II medium (vitamin C was added to be the final concentration of 100mM if it is added) containing 5nM MTX and $400 \mu\text{g/ml}$ of G418 were added thereto, and culture were performed for four days. Culture supernatant so obtained were collected and was dialyzed to TBS (prepared from TBS powder (Takara Shuzo)), thereafter, it was dialyzed to TBSC (5mM CaCl_2 , TBS).

Next, it was purified by mannan-agarose (SIGMA). Namely, mannan-agarose were packed in column (Column PD-10, Empty, Pharmacia), then the dialyzed culture solution were passed therethrough, were washed with TBSC and were eluted with TBSE (10mM EDTA, TBS). After such elution, 1M CaCl_2 were added thereto to be its final concentration of 15mM, then the solution were applied again to the mannan-agarose, then were washed with TBSC and were eluted with TBS containing 100mM mannose, thereafter, the purified rhMBP products were produced by re-dialyzing such re-eluted solution to TBSC.

(2) PAGE analyse of Purified rhMBP

hMBP produced in Example 4(1) were analyzed by PAGE. SDS-PAGE employed polyacrylamide gel (Daichi Pure Chemical) having the concentration gradient of 4~20% under the non-reducing condition, polyacrylamide gel (Daichi Pure Chemical) having the concentration gradient of 10~20% under the reducing condition and polyacrylamide gel (Daichi Pure Chemical) having the concentration gradient of 4~20% for the native PAGE. Polypeptides were stained with 1% Coomassie Blue (CBB). Results thereof are shown in Figure 15. In Figure 15, Lane M is the molecular weight marker (prestained protein marker broad range (NEW ENGLAND BIO Labs)), Lane 1 is the native hMBP, Lane 2 is rhMBP (cultured with vitamin C) and Lane 3 is rhMBP (cultured without vitamin C).

As shown in Figure 15, although there was band at the molecular weight which is same to the native hMBP on SDS-PAGE under the reduction condition, there were bands pattern of which are different from those of the native hMBP on SDS-PAGE under the non-reducing condition and the native PAGE.

(3) Gel-Filtration Chromatography analysis of Purified rhMBP

Purified rhMBP were gel-filtrated with Superose 6 HR10/30 (ϕ 10mm \times 300mm length; Pharmacia) at flow rate of 0.5ml/min. using 20mM Tris-HCl (pH 8.0), 0.15 NaCl, 5 mM EDTA. 40 μ g of rhMBP was applied on this column and was measured at 280nm absorbance.

Gel-Filtration Standard (thyroglobulin (670kDa), bovine γ -globulin (158kDa), chicken ovalbumin (44kDa), bovine myoglobin (17kDa) Bio-Rad) were employed for calibration of the column. As shown in Figure 16, there were major peaks at 300kDa in rhMBP and at 1,300kDa in the native hMBP.

Example 5 : Sugar Binding Activities and Sugar Binding
Specificities by rhMBP and native hMBP

Microtiter Plates were treated with 100 μ l of coating buffer (15mM sodium carbonate, 35mM sodium hydrogen carbonate, 0.05% sodium azide, pH 9.6) containing mannan (10 μ g/ml:SIGMA) at 4 $^{\circ}$ C overnight. After each treatment step, the plates were washed three times with TBSNTC solution (TBS, 0.05% sodium azide, 0.05% Tween 20 (Registered Trade Mark), 5mM calcium chloride). After completing the coating of the plates, the plates were treated and blocked with BlockAce (Dainippon Pharmaceutical) at room temperature for one hour.

After washing them, samples of stepwise dilution of the native hMBP, rhMBP (cultured with vitamin C), rhMBP (cultured without vitamin C) having the concentration of 200, 100, 50, 25, 12.5, 6.25ng/ml, combination samples of 200ng/ml of each hMBP with EDTA added to be its concentration of 10mM, and combination samples of 50ng/ml of each hMBP with mannose added to be its concentration of 100mM were prepared, thereafter, 100 μ l of each of them were poured into each well and were incubated at 37 $^{\circ}$ C for one hour. After washing them, biotinylated anti-rabbit anti-

hMBP antibody (biotinylated with EZ-Link (Registered Trade Mark) Sulfo-NHS-LC-Biotin (PIACE)) diluted 1,000 times with TBSNTC were added thereto, then they were incubated at 37°C for one hour and were washed. Then, a complex of avidin and biotinylated alkaline phosphatase was formed at 37°C for 30 minutes with VECTASTAIN ABC-AP STANDARD KIT (VECTOR) and was washed. Finally, 100 μ l of TMB substrate solution (TMB Microwell Peroxidase Substrate System: KPL) were added to each well. After incubating them at room temperature for 30 minutes, 100 μ l of 1M phosphoric acid were added thereto, and their absorbance were measured at 450nm (Model 450 Microplate Reader; Bio-Rad). Then, evaluation on sugar inhibiting activities were performed according to the method of Lu et al., (Biochem. J., Vol.284, pp.795-802 (1992)) employing this ELISA system.

After coating the microtiter plates with mannan (1 μ g/100 μ l well), the native hMBP and rhMBP (cultured with or without vitamin C) were reacted under the co-presence of the sugars in their final concentration of 100, 50, 25, 12.5, 6.3, 3.1, 1.6mM. Sugar binding specificity was indicated as I so with regard to sugar concentration necessary to halve binding activities in comparison with the suppression curve. Results thereof are shown in the following Table 1.

Table 1

Sugar Binding Specificities on rhMBP and native hMBP

Sugars	I ₅₀ (mM) *		
	native hMBP	rhMBP (with Vitamin C)	rhMBP (without Vitamin C)
N-Acetyl-D-Glucosamine	2.7	3.6	3.8
L - Fucose	4.2	4.4	8.7
D - Fucose	33.5	39.1	86.7
D - Mannose	3.7	6.7	6.8
Maltose	7.4	6.4	7.4
N-Acetyl-D-Mannosamine	4.4	6.9	6.9
Glucose	3.2	2.0	2.4
Galactose	24.2	29.8	36.7
N-Acetyl-D-Galactosamine	>100	>100	>100
Lactose	36.0	46.6	59.4

* : Sugar concentration to halve binding activities
with mannan

Apparently from the results shown in Table 1, sugar binding specificities by rhMBP are substantially identical to those by the native hMBP. Then, as shown in Figure 17, sugar binding activity by rhMBP are similar to those by the native hMBP.

Example 6 : Hemagglutination Inhibition (HI) Activities

(1) Viruses

Influenza A virus A/Ibaraki/1/90 (H3N2:Influenza A virus (A-Hong Kong)) were used to evaluate Hemagglutination Inhibition (HI) Activities.

Viruses were subcultured 40 times with CAM (chorioallantoic membrane) from the matured egg according to the standard method and were stored at -70°C until use. As a growth medium for the viruses, Eagle MEM medium (Nissui Pharmaceutical) containing 3% vitamin for tissue culture, 0.2% albumin, 0.1% glucose and 0.2ng/ml acetylated trypsin was used.

(2) Hemagglutination Inhibition (HI) Activities by rhMBP

In accordance with the method of Okuno et al., (J. Clin. Microbiol., Vol.28, pp.1308-1313 (1990)), Hemagglutination Inhibition (HI) activities were determined. Namely, native hMBP and rhMBP (cultured with or without Vitamin C) ($5\text{ }\mu\text{g/ml}$) were diluted double-stepwise with $25\text{ }\mu\text{l}$ of TBSC on 96-well microplates. $25\text{ }\mu\text{l}$ of 16HAU (Hemagglutination Unit) virus solution were added to each of MBP solution diluted stepwise, then were reacted at 37°C for 60 minutes, and $50\text{ }\mu\text{l}$ of 0.5% chicken's erythrocytes solution were added thereto. After the incubation at 4°C for 60 minutes, effects on rhMBP against viral hemagglutination on chick's erythrocytes were observed. Results are shown in the following Table 2 and Figure 18.

Table 2

Minimum Protein Concentration (ng/ml)
for Hemagglutination Inhibition (HI) Activities
by rhMBP and native hMBP

	Minimum Protein Concentration (ng/ml) for HI Activities
native hMBP	4 0
rhMBP (with Vitamin C)	8 0
rhMBP (without Vitamin C)	8 0

Results shown in Table 2 and Figure 18 indicated that Hemagglutination Inhibition (HI) activities by rhMBP are not inferior to that by native hMBP.

Example 7 : Neutralization Activities

(1) Viruses

Influenza A virus A/Ibaraki/1/90 employed in Example 6 were used.

(2) Neutralization Activities

Neutralization Activities were evaluated according to the method of Okuno et al., (J. Clin. Microbiol., Vol.28, pp. 1308-1313 (1990)). The native hMBP and rhMBP (cultured with or without vitamin C) were diluted double-stepwise with TBSC and were mixed equivalently with viral solution of 50 Focus Forming Unit (FFU)/25 μ l, thereafter, they were

reacted at 37°C for 60 minutes. 50 μ l of these reaction solution were inoculated into three wells per each concentration of MBP dilution on 96-well microplates wherein Madin-Darby Canine Kidney (MDCK) cells were monolayer cultured in Eagle MEM medium containing 10% bovine fetal serum (GIBCO). After incubating them at 35°C for 60 minutes, cells were washed and were added thereto growth medium for influenza viruses containing 0.5% tragacanth gum (Wako Pure Chemical Industries), thereafter, they were cultured for 24 hours in CO₂ incubator.

After the culture, cells were washed and were fixed with ethanol. After air-drying the cells, they were reacted with each of anti-influenza hyperimmune rabbit serum, anti-rabbit IgG goat serum (ICN Pharmaceuticals) and peroxidase anti-peroxidase (rabbit) complex (ICN Pharmaceuticals) at 37°C for 30 minutes. After washing them with PBS, DAB solution (SIGMA) were added thereto, and reaction was continued until color of the virus-infected focus are changed to reddish-brown. Then, after washing them with tap water and air-drying the same, number of virus-infected focus were counted.

Figure 19 shows results obtained by comparison on the neutralization activities for influenza A viruses in the native hMBP, rhMBP fraction (cultured in the medium containing vitamin C), rhMBP fraction (cultivated in the medium without vitamin C) and said fractions combined these with 100mM mannose. Neutralization titer were indicated as reduction rate of FFU based on 100% counts obtained,

instead of MBP, from mixture of viral solution and TBSC only. As a result thereof, similar to the native hMBP, rhMBP (cultured with or without vitamin C) had neutralization activities for influenza virus, and such activities were inhibited by addition of mannose.

(3) Binding Activities to HIV-1, HBV and Influenza A virus

Binding activities on rhMBP to HIV-1, HBV and Influenza A virus were determined by electrophoresing the following viral structural proteins, transferring them to membranes, binding thereto rhMBP and detecting them with labeled antibody.

Necessary amounts of viral structural proteins for the electrophoresis were 0.25 μ g of HIV-gp120 (HIV_{111B}-gp120) (ADVANCED BIOTECHNOLOGIES INCORPORATED (ABI)), 0.25 μ g of HIV-gp160 (HIV_{111B}-gp160) (ABI), 10 μ g of HBS (Hepatitis B Surface Antigen (HBsAg) (ABI), Subtype ad), Influenza A virus (IAV; presented by The Research Foundation For Osaka University Research Institute for Microbial Diseases), 5 μ g of H1N1 Yamagata virion and 5 μ g of H3N2 Bejin virion.

SDS-PAGE employed polyacrylamide gel having the concentration gradient of 4~20%, and HIV-1 and HBS were electrophoresed under reducing condition. After the electrophoresis, they were transferred to Immobilon-P⁵⁰ transfer membrane (Millipore) with Nova Blot (Pharmacia) by using semi-dry electroblot buffer kit (Owl Scientific). After such transfer, they were blocked with BlockAce (Dainippon Pharmaceutical) at room temperature for

one hour. Then they were washed three times for 10 minutes with TBSTC (0.05% Tween 20 (Registered Trade Mark), 5mM CaCl₂, TBS) or TBSTE (0.05% Tween 20 (Registered Trade Mark), 5mM EDTA, TBS) (control which inhibits calcium ion (Ca²⁺) dependent binding to carbohydrate recognition domain of rhMBP), and the solution diluted rhMBP to 1.0 μg/ml with TBSTC or TBSTE were reacted at room temperature for one hour.

In accordance with said procedure, after washing them with TBSTC or TBSTE, anti-human MBP polyclonal antibody diluted 1000 times with TBSTC were added thereto, and they were reacted at room temperature for one hour. After washing them with TBSTC, anti-rabbit IgG alkaline phosphatase label (Chemicon International) diluted 5000 times with TBSTC were added thereto, and they were reacted at room temperature for 30 minutes. After washing them with TBSTC, color were developed with NBT/BCIP (GIBCO).

Results are shown in Figure 20. As shown in Figure 20, it was demonstrated that the present rhMBP have binding activities to any of HIV-1, HBV and Influenza A virus.

Example 8: Viral Growth (Infection Spread)

Inhibition Activities

(1) Viruses

Influenza A virus A/Ibaraki/1/90 employed in Example 6 were used.

(2) Viral Growth (Infection Spread) Inhibition Activities

MDCK cells were monolayer cultured in Eagle MEM medium containing 10% bovine fetal serum (GIBCO) on 24-well microtiter plates and influenza viruses were inoculated thereinto to be 30 FFU per well. After incubating them at 35°C for 60 minutes, cells were washed and were added thereto 1ml/well growth medium for influenza viruses containing 0.5% tragacanth gum. Further, native hMBP, rhMBP (cultured with vitamin C), rhMBP (cultured without vitamin C), bovine serum albumin were added thereto to be 0.5 μ g/ml and 1 μ g/ml per well, and they were cultured for three days.

After washing the cells, similar steps were taken along with Neutralization Activities of Example 7 (2), gross area of the virus-infected focus were determined with PAP staining. Results thereof are shown in Figure 21. As a control, samples cultured under the co-presence of 100mM mannose were employed (Right Column in Figure 21). Apparently from the results shown in Figure 21, rhMBP reduced focus area infected by influenza viruses concentration-dependently and exhibited an inhibition effect on viral growth.

Example 9: Activities on rhMBP for Activating Complement

(1) Viruses

As influenza A virus, A/Ibaraki/1/90 (H3N2) employed in Example 6 were used.

(2) Preparation of Sensitized Sheep Erythrocyte

After washing Sheep Erythrocyte (Japan Biotest Institute) with gelatin-veronal buffer ($1 \times$ veronal (145mM NaCl, 15.6mM 5,5-diethyl barbituric acid, 9.09mM 5,5-diethyl sodium barbiturate), 1% gelatin, 0.25mM CaCl_2 , 0.82mM MgCl_2), they were diluted with gelatin-veronal buffer to be its concentration of 1×10^9 cell/ml. After mixing them with 10ml of Sheep Erythrocytet (1×10^9 cell/ml), 5ml of chromium chloride (0.5mg/ml) and 5ml of mannan ($60 \mu\text{g/ml}$), then were incubated at room temperature for five minutes, and sensitized sheep erythrocyte were prepared by washing them several times with gelatin-veronal buffer and suspending the same into gelatin-veronal buffer to be readjusted its concentration of 1×10^9 cell/ml.

(3) Activation of Complement

400 μl of each of native hMBP and rhMBP (cultured with or without vitamin C) and 100 μl of sensitized sheep erythrocyte were mixed thereamong, the mixture so produced were incubated at room temperature for 15 minutes (each lectin concentration were 1, 10, 100 and 1000ng/tube as a final concentration).

After the centrifugation, deposits were suspended in 1.1ml of veronal buffer. 400 μl of guinea pig complement (ICN Pharmaceuticals: immanent MBP of which were removed with mannan-column and diluted 20 times with gelatin-veronal buffer) were added thereto, and they were incubated at 37°C for 60 minutes and absorbance on supernatant were measured

at 541nm. Control was completely hemolyzed erythrocyte prepared by adding 1400 μ l of distilled water to 100 μ l of sensitized sheep erythrocyte. In an experiment on inhibition by mannose, sensitized sheep erythrocyte and hMBP were simultaneously added at the reaction.

Results thereof are shown in Figure 22. As shown in Figure 22, rhMBP (cultured with or without vitamin C) hemolyzed concentration-dependently sensitized sheep erythrocyte substantially like the native hMBP.

In view of this fact, it is deduced that rhMBP binds to mannan at the surface of the sensitized sheep erythrocyte, then the complements are activated accordingly. These activities were suppressed by an addition of mannose.

[Industrial Applicability]

Accordingly, the present invention realizes means for the large-scale production of homogenous rhMBP which exhibits equivalent physiological activities to be offered by MBP obtained conventionally from living body with low yield. Since the present rhMBP have similar physiological activities to be offered by the native hMBP, they will offer the various effects including an application thereof to the medicine field.